SURGICAL WAR EXPERIENCES

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The following notes suffer from several defects and must be regarded only as the expression of my purely personal views. They are based on so brief a period of work as two and a half months, during which, faced as I was with inappropriate housing for the purpose and with a staff unaccustomed to team-work, the problem of establishing a satisfactory serviceable hospital occupied a great deal of my time. Moreover, they relate entirely to the severe winter conditions in Northern Scandinavia. On certain points, especially where there was not complete agreement, I have made use of my Finnish colleagues' experiences. I did not myself take part in the work of the hospitals in the most advanced positions, but only in those which correspond to our Swedish divisional and base hospitals.

Situation of the Field Hospitals

Perhaps the most striking feature is that the hospital services were situated relatively far in the rear. On the sectors of the front where I was on duty the field hospital was usually thirty-five to forty kilometres or more behind the front line, and the formations corresponding to base hospitals a further 100 kilometres beyond that. The reason for this, of course, was, first, that there was no actual "front" except that near the roads, while the patrols moved freely about over large tracts of country; and, secondly, that the network of roads was rather scanty. The result of this was that with regard to both staff and equipment the hospital worked under conditions much more like those in peacetime than was hitherto thought possible. V.A.D.s and "lottas" were extensively employed, and the female personnel was thus just as numerous as in peacetime, perhaps even more so. It has often been pointed out that provision for war casualties is primarily a transport problem, and this is undoubtedly true. Given an adequate supply of transport, however, I think that the problem has been solved very satisfactorily by converting traffic omnibuses into hospital ambulances. Nevertheless it cannot be emphasized too strongly that a standardization of the stretcher apparatus is absolutely necessary. It ought never to happen that a wounded person cannot be carried on the same stretcher all the way from the front line to the place where he is to be taken care of. The Swedish army stretcher is extraordinarily good in almost every respect. It might perhaps be a little broader and have handles which can be dropped downwards. A good many observations relating to the construction of the motor-cars and their equipment in winter-time might be added, but they are perhaps more of interest to another class of reader.

The work itself varies enormously in intensity. At times the radiological and surgical departments are employed ceaselessly day and night, while at other times there may be only two or three cases of a trivial kind a day. These fluctuations are equalized to some extent in the hospital wards, but not very appreciably. In view of this I believe that the hospitals should not be staffed with the full complement of doctors from the outset, but with a standard

personnel which under greater pressure could be augmented from a reserve of doctors located a short distance away. The system of separating the operating theatres from the wards, with special doctors for the latter, is not satisfactory. War injuries require that the doctors who operate should be responsible for the subsequent care of the patient, at any rate during the first few days. It is desirable that each hospital unit should have at its disposal a skilful electrotechnician as well as a technical expert in radiology. It is very difficult to manage without such when one has to install and repair radiological apparatus and reserve lighting under primitive conditions, or replace lost and defective parts of sterilization plants and innumerable other things. The services of dentists ought not to be dispensed with either, and it is advisable to have physicians on the staff, because at times the field hospitals are very largely filled with more or less banal cases of "common colds." A number of purely "civil" complaints, particularly digestive diseases and sciatica, are very apt to occur on active service.

A very difficult problem, at any rate with our present form of building, is to arrange that the staff gets adequate rest. The casualty transports arrive fairly late at night and the work goes on continuously. In the day-time there is often one air raid warning after another, with or without bombing. For example, one of our field hospitals was bombarded six times in the course of a week; large bombs burst close to it and heavy frozen lumps of earth were projected through the roof of a ward. One day there were eight air raid warnings, so that the staff and ambulant patients spent the greater part of the daylight hours in the shelter. The entire work of the hospital was badly disorganized. The food was spoiled, and the meals had to be served whenever possible. The all-important factor for the healing of the wounds—namely, rest—was completely in abeyance. The mental composure of some of the patients, especially those in bed, as well as of the staff, was gradually disturbed, so that true fear psychosis occurred. My experience is that as a moral support it is essential to leave one nurse in each ward and one doctor for about every three wards during an air raid warning. All the rest would go to the shelter.

Treatment of Wounds

As regards wound treatment, the following is perhaps to a great extent a repetition of what has often been pointed out during recent years.

An x-ray examination of almost every case is necessary. The ideal method is excision (and suture). In the majority of cases it can be adopted even after the first twelve hours. It is usually not an easy operation: it demands technical skill, anatomical knowledge, and speed on the part of the operator. Skin, subcutaneous tissue, and fascia can be cut out in one mass, with one opening of the wound. Then comes the conscientious and really arduous operation of removing all foreign bodies or the tissue contaminated by them in the depths of the wound, and all tissue which is not definitely viable. The larger nerves and vessels, tendons, and, if possible, the not completely free bone splinters are avoided. Every pocket and corner of the wound must be explored. Then the other opening of the wound is dealt with in the same way. The result should be a completely clean and dry wound with great loss of tissue, and the problem now is the treatment. In case of uncertainty it is best to fill the wound with fish-liver-oil ointment and apply a supporting bandage, preferably a plaster one. If the operation is regarded as satisfactory the wound should be sutured. I have employed a few large deep adaptation stitches, but have dispensed with sunken sutures and drainage. I have had no experiences which would induce me to alter these rules. A gauze drain is undoubtedly

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to be condemned, for, since albumin coagulation occurs in its meshes, it only acts as a plug. Rubber tubes, at least in a few cases, have appeared to be the cause of threatened secondary haemorrhage through rupture of a vessel. A small rubber drainage tube for twenty-four or at most forty-eight hours is, however, quite permissible and appropriate. Suture is out of the question when the wound is old or much torn; recourse is then had to ointment and fixation bandages.

If one has to deal with retained missiles, whether grenade splinter or gun projectile, it is often best to remove the foreign body by an operation through sound tissue. I have not hesitated to close such an incision primarily and in layers. It has happened, however, that the sutures had to be removed later on account of suppuration of the wound. Gunshot tracks and wound sinuses could not, as a rule, be thoroughly excised (for example, in patients shot through the pelvis with the bullet in the opposite hip region, or wounded through the chest with shell splinters in the supraclavicular fossa, or through the face with splinters in the neck muscles, etc.). They were left open, with an ointment bandage, often after excision of the mouth of the wound. *Small* splinters in anatomically harmless regions or in situations which are very difficult to reach—for example, deep down in the liver, in the lung hilum, or in the pelvic connective tissue—must be left, so long as they do not cause local symptoms of an alarming nature. The shot-wound openings are left to heal "under the scab." Bullets from rifles and automatic weapons, as has often been pointed out, are far less dangerous than shell and bomb fragments from the point of view of infection, and form an exception to the above strict mode of procedure. I have only very exceptionally made use of sunken sutures. Tension on the sutures must always be avoided, and a haematoma must never be left untreated. Attention has already been drawn to the advantage to the patient of being under the supervision of the same surgeon for the first few days, and this cannot be emphasized too much. If this cannot be done—should it, for example, be necessary to transport him at once to the rear—then it is better not to suture the wound at all, but merely to excise and immobilize it. Exceptions to this rule are, of course, the recognized triad: penetrating shot wound of the skull; penetrating shot wound of a joint; and open pneumothorax, which ought to be closed at once and with precision.

With the limited experience I have had it is hardly worth while discussing injuries to the various parts of the body. I should only like to point out that clean shot wounds right through the chest, and those in which small fragments are retained, heal surprisingly well under a purely conservative expectant treatment even if there is extensive subcutaneous emphysema. It is also quite exceptional that a haemothorax needs to be punctured and drawn off more than once. In these cases particularly I have the purely subjective unverified impression that routine treatment with sulphonamide preparations is of value. Another set of cases, in which a number of temperature curves seem to give definite support to the view that the conception of the effect of these preparations obtained in peacetime surgery is the right one, are the septic ones with swinging temperature. It may happen that a late-appearing—for example, week-old—suppurating wound with foreign body and sequestrum has been operated upon and left open, in conjunction with which sulphonamide has been used for some days, but it still remains septic. A fresh application of sulphonamide after ten to fourteen days is not uncommonly followed by a critical and permanent fall in temperature.

There are also a bewildering number of symptoms arising from the vegetative nervous system in connexion with shot wounds of the extremities. A peripheral rise or fall in temperature, hyperidrosis, erythralgia, localized oedema, and severe attacks of pain are common findings.

Some of them disappear quickly, others persist for a long time. The whole of this interesting subject really deserves a thorough investigation, when the material can be elaborated.

Frostbite and Burns

Apart from shot wounds I think that two kinds of common war injuries ought to be briefly mentioned—namely, frostbite, and burns from certain types of incendiary bombs. In accordance with old custom the treatment of local frostbite is always the same: the patient—who is usually placed in the open air or in a cold room—has the affected part of his body rubbed with snow and afterwards immersed in cold water. More than ten years' experience at Boden and Östersund has shown me the danger of this theoretically ill-founded treatment and the damage actually caused by it.

The frostbitten patient should be put in a warm room and, if possible, given a warm drink. Then the benumbed limb should be pinched and massaged *from* the centre *towards* the periphery and rubbed with a dry coarse towel; but always great care must be taken that the skin is not damaged but follows in the movement. As soon as the circulation has been restored movement is made further towards the periphery; directly a joint is passed it should be subjected to slight passive movement, but without force. These passive movements should soon be replaced by active ones. In this way the affected part is systematically dealt with. The use of snow or water at this stage leads to maceration of the skin, with danger of infection and gangrene. Alternate hot and cold baths, however, are useful in the after-treatment. Frost blisters are best left to themselves without bandaging, whereby the healing takes place in a moist sterile chamber. Deeper frostbites can with advantage be treated with tannic acid or, if they become infected, with fish-liver-oil ointment and fixation.

Besides the usual electron and thermite incendiary bombs the Russians employed large incendiary bombs filled with a greyish-brown mass of probably crude petroleum (massuth), which, at any rate at low temperature, had the consistency of vaselin. By detonation this substance is set alight and sprayed over a wide area. Its action on living objects is dreadful. Uncovered parts of the body receive extensive deep third-degree burns, but it also causes an apparently chemical erosion, similar to that found in alkali injuries. Extensive oedema, with the face swollen to two or three times its natural size, is also characteristic. The combustion gases produce a picture not unlike corrosive bronchitis. Cough, pain in the chest, superficial rapid breathing, and aphonia occur soon after the injury. If the pulse rate becomes rapid or cyanosis gives way to pallor the prognosis is very bad indeed, and death occurs with the picture of increasing respiratory failure. Otherwise the symptoms usually disappear slowly in the course of some weeks. The treatment consists, above all, in rest, which, however, is extremely difficult to ensure, because the patients are among those most affected by the terror of air attacks. At the sound of an air raid warning many of them, consumed with unutterable fear, jump out of bed, throw at most a blanket over their shoulders, and rush into the open, away from hospital and shelter, even in extremely cold weather. Sulphonamide preparations are generally used, and venesection is performed for cyanosis. Morphine is avoided where contraindicated, but cannot be dispensed with, for the patients' pain is too severe and their terror too great. Barbituric acid preparations, even in large doses, are unable to induce the much-needed rest. These patients are perhaps the most trying of all to the doctor. They are so entirely dominated by their sense of fear that it is

impossible to obtain the necessary psychic contact with them. The local lesions are best treated by tannic acid coagulation, of which I have no personal experience, because all the cases I saw had had different kinds of ointment applied before admission.

General Treatment

Rest, warmth, and fluids are the all-important factors in the general treatment of war injuries. What has been written above shows how difficult it is to ensure adequate rest for the patients. Warmth, and fluid in the form of a warm sweet drink, should be supplied at once as a routine measure to all patients except those with abdominal wounds. Injections of intravenous glucose drops should be given before and during the operation to all patients suffering from shock, as well as to all those who are suspected of being on the verge of a state of shock. The injections should be continued for some days.

The form of narcosis most often used was an intravenous injection of narcotal, following an injection of 4 c.cm. of 20 per cent. magnesium sulphate solution and 2 cg. of morphine. Even greatly affected patients have stood this form of narcosis remarkably well. The amounts injected are small. This narcotic remedy is perhaps as suitable for shock patients as it is for elderly people. A post-operative state of excitability has been observed. Ethocaine applied locally has been largely used. It seems, however, as if these highly exhausted and nerve-racked people are not so well adapted to local anaesthesia, at least during the first twelve hours. They often evince distinct reactions to pain on insertion of the needle, and it is difficult to obtain a satisfactory anaesthesia. The reaction is of course normal again after rest and sleep.

After-treatment

The view that the work of the surgeon is only half done when the patient leaves the operating table has gained more and more ground. The planning and supervision of the after-treatment is a difficult art. I am myself a convinced supporter of the view that everything possible should be done at the operation to give Nature a free field in which to exert her own bactericidal and healing powers. Afterwards one factor dominates all the others: namely, rest—immobilization. Well-applied supporting plaster bandages, metal splints, or extension apparatus encompassing a sufficient number of joints are the best forms of treatment for this purpose. Next in importance is to avoid changing the bandages. The conditions under which I had to work, and the time at my disposal, made it impossible to carry out both these requirements. When the language question put obstacles in the way of the important personal contact between doctor and patient it was more difficult than usual to make the patient understand that his discomfort was caused by the injury and not by the bandaging; and, in particular, the surgical appliances which confined the patient to bed and thus forced him to stay in the ward during an air raid alarm were far from popular. Here the surgeon had to capitulate in the presence of powerful psychic factors; it would presumably have been possible to conquer even these in the course of time. It was still more difficult to obviate the changing of bandages. In the native hospitals and polyclinics of one of the districts where I worked the bandages were changed daily, and even very trifling injuries were heavily bandaged. And when one is convinced, by the peacetime treatment of accidents—and war surgery is indeed nothing but the care of exceptionally

severe and unusually numerous accidents—of the advantages which the open treatment of certain cases and the closed treatment in plaster and with fish-liver-oil ointment of others offer, it is extremely difficult to give way to local prejudice. It turned out, however, that it was not possible to assert one's authority in the face of solid opposition on the part of both patients and native nurses. Only gradually and by choosing appropriate cases could a change in the desired direction be accomplished. A large turban-like bandage was, however, when I departed, still much more popular than a small piece of adhesive plaster or mastisol bandage, which would have been quite sufficient. Hostile air activity and numerous deep-rooted psychic causes have thus prevented me from obtaining a clear picture of the right lines to follow in the after-treatment of war wounds; but I am convinced on the whole that the methods indicated above—often attributed to Böhler and Löhr—give the best and quickest results.

Summary

A report is given of personal impressions and experiences after two and a half months' work at the divisional and base hospitals in Finland. On account of the mobility of the front these hospitals had to be transferred at least thirty to forty kilometres further back, with the result that they could be run more on a peacetime basis. The transport problem was solved by using converted traffic omnibuses. Standardized stretcher apparatus was found to be absolutely necessary.

The hospital work varied greatly in intensity, and it is suggested that when the pressure is at its height the staff should be augmented by doctors from the reserve.

Each hospital unit should have at its disposal a technical engineer, a dentist, a physician, etc.

The repeated air raid alarms interfere with the work of the hospital and disturb the rest of personnel and patients, and also cause fear psychosis: one field hospital was bombed six times in a week.

The treatment of wounds consists in excision (plus suture); when there were great loss of tissue and doubt as to treatment the wound was filled with fish-liver-oil ointment and a supporting bandage applied. Large deep adaptation stitches were employed for suturing the wounds. Small rubber drainage tubes proved to be suitable. Old mutilated wounds were treated with ointment and fixation bandages. Foreign bodies were removed by an operation through sound tissue (with primary suture). Clean shot wounds right through the chest were successfully given conservative treatment: these cases and the septic ones with swinging temperature seem to react well to sulphonamide.

The manifold symptoms arising from the vegetative nervous system in shot wounds of the extremities deserve further investigation.

Frostbites were treated with massage towards the periphery, followed later by alternate hot and cold baths, and in severe cases with tannic acid, but, if infected, with fish-liver oil and fixation.

Besides the usual electron and thermite incendiary bombs the Russians used large incendiary bombs probably filled with crude petroleum; these caused third-degree burns and chemical erosions on the naked skin. The combustion gases produced a lesion resembling corrosive bronchitis. These patients are very difficult to treat on account of their sense of fear. The form of narcosis most often used was an intravenous injection of narcotal, but local anaesthesia was unsuitable for these highly exhausted patients.

Surgical appliances which made it difficult for the patients to take refuge in the air raid shelters were very unpopular.

I should not like to conclude this short review without expressing the gratitude we all feel towards our Finnish colleagues, both to those in whose areas of control we worked

and to our young comrades who, in the capacity of liaison officers, have been responsible for contact and have had to bear the brunt of the "paper" war. We have enjoyed far more than ordinary loyalty and comradeship. All things possible have been done to smoothe the way for us. These friends, who were worn out by hard work and sorely tried by personal grief, have by sacrificing much-needed time for rest and recreation not only carried out our wishes but even tried to forestall them.

THE RATIONALE OF COMPLETE IMMOBILIZATION IN TREATMENT OF INFECTED WOUNDS

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With the prospect of thousands of casualties arising in the near future from gunshot wounds and from bomb splinters it becomes a matter of urgency to review the methods at present advocated for their treatment. If one may judge from articles in recent numbers of our medical journals it would appear that surgeons with extensive experience of the treatment of injuries during the last war are still recommending those methods which they considered most satisfactory in 1918. Some reference may be found to the fact that a new method based on the work of Winnett-Orr has been employed by the surgeons of the Republican side during the Spanish Civil War.

It is the purpose of this review to summarize the available literature dealing with the spread of infection in the body, particularly in the limbs, and to show that a good case based on experimental work may be made out for the closed-plaster method of treating infected wounds. The essential feature of this method, which has been fully described by Trueta (1939a), is the complete immobilization of the soft tissues. The experience gained from its use in the treatment of large numbers of infected wounds has shown that under conditions of complete immobilization the tissues of the body are capable of resisting invasion by many different varieties of bacteria, even when the latter continue to grow freely in the wound. Later, when the initial danger of invasion has been overcome, the cells and body fluids are capable of destroying these organisms and allowing the normal processes of repair to take place.

From the outset it must be emphasized that the aim of this form of treatment is to provide the optimal conditions for the body itself to destroy the invaders, and no attempt is made to kill them by external agents: this consideration is paramount, irrespective of the possible virulence of the organisms that might be present. It is obvious that if the common pyogenic bacteria (but perhaps not organisms that normally remain fixed and damage the host by the production of a powerful exotoxin) can be kept localized in the tissues their power to injure the host is very much diminished.

Experimental Evidence

Movement of Bacteria in the Body.—It has long been known that bacteria can travel very rapidly from recent

wounds to the internal organs; indeed, non-pathogenic bacteria have been found in the spleen five minutes after being placed in wounds on the backs of rabbits (Schimmelbusch, 1894). This rapid spread must mean that organisms enter either the blood stream or the lymph stream. It is difficult to imagine them entering directly through the cut ends of the smaller vessels; either these would be blocked by thrombi or, if still patent, the current of the escaping fluid should prevent particles being carried in. The bacteria must penetrate the walls of the blood or lymph capillaries. Pawlowsky (1900) was convinced that bacteria travelled by the lymphatics. In support of this it has been found that bacteria injected into the knee-joints of rabbits may be isolated from the inguinal, iliac, and lumbar lymph glands within ten minutes of the injection. It also indicates that the glands do not invariably act as efficient filters for the organisms (Noetzel, 1906). Three varieties of bacteria injected under the skin on the backs of rabbits have been cultured from the lymph obtained from the thoracic duct at a time when cultures of the blood were sterile (Finucci, 1935). Wells and Johnstone (1907) showed that *B. coli* injected into the peritoneal cavity of dogs appeared in large numbers in the lymph from the thoracic duct; in rabbits they found that *B. coli* placed in the peritoneal cavity reached the blood stream after a longer interval, and in smaller numbers if the thoracic duct had been tied. Similarly, virulent bacteria placed in the nasal cavities of rabbits can be isolated from the lymph removed by a cannula from the cervical lymph duct (Schulz, Warren, and Drinker, 1938). The exact mechanism by which the bacteria reach the lymph is not clear. Although lymph draining an inflamed area may contain large numbers of polymorphonuclear leucocytes (Menkin, 1929), virulent capsulated bacteria that are not phagocytosed may readily enter the lymph stream (Field, Schaffer, Enders, and Drinker, 1937).

Absorption of Substances from the Tissues.—Absorption is carried out by both the blood and lymph streams; the amounts removed by each are dependent upon the size of the molecules of the substance being absorbed. Those of low molecular weight are absorbed by the blood stream alone; as the molecular weight rises so does an increasing proportion get carried away by the lymphatics (Drinker and Field, 1933). Substances of a molecular weight equal to that of serum proteins are absorbed entirely by the lymphatics. This has been shown to be the case both for subcutaneous tissues (Lewis, 1921) and for joints (Bauer, Short, and Bennett, 1933). Since this is the chief channel of absorption for protein particles of relatively small size it is not surprising to find that microscopically visible particulate matter travels entirely by the lymphatics and not by the blood stream. This, for instance, has been shown to be the case in studies on the absorption from joints (Bauer, Ropes, and Waine, 1940).

Importance of the Lymph Stream.—It is obvious that any measure that will reduce the amount of lymph flowing through a limb must at the same time greatly decrease the chances of absorption of bacteria and their toxic products. It is well known that the amount of lymph draining from a limb can be varied within very wide limits by relatively simple means. Thus it is impossible to obtain any lymph from the leg of an animal at rest; it begins to flow as soon as the limb is moved or massaged. Recent work has shown that both the amount of lymph produced and the rate at which it flows can be greatly increased by active or passive movements, by warmth, and by massage